International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)
ISSN (P): 2249–6890; ISSN (E): 2249–8001
Vol. 9, Issue 5, Oct 2019, 725–732

FABRICATION AND STRUCTURAL ANALYSIS OF ALUMINIUM ALLOY (LM 16) REINFORCED WITH GRAPHITE AND GRANITE POWDER

G. R. KRISHNA PRASAD YADAV, J. KISHORE & V. MAHANANDI REDDY

Department of Mechanical Engineering, GPREC Kurnool, Andhra Pradesh, India

ABSTRACT

Most pistons are made with die-cast or gravity-cast aluminum alloy. Cast pistons has good structural integrity, low cost, cast iron is brittle than the aluminum alloy and forged pistons are not for all applications. As each of them has its own disadvantages, to eliminate those disadvantages to the maximum extent we have chosen this project. Now a days, aluminum and its alloys have grate demand for the applications of automobile and aerospace, aluminum alloys are higher strength to weight ratio. We center around the combination and tribological investigations of aluminum LM16, graphite, and rock dust composites. For this situation, AL LM16 strengthened with graphite and rock dust by metal lattice composite in various rates, which results in increment of the elasticity, hardness and furthermore increment of the wear opposition of the base combination

KEYWORDS: AL-LM16, Gravity-Cast Aluminum Alloy & Metal Matrix Composite

Received: Jun 18, 2019; **Accepted:** Jul 10, 2019; **Published:** Sep 23, 2019; **Paper Id.:** IJMPERDOCT201964

Original Article

INTRODUCTION

Over the most recent two decades, inquire about has moved from solid materials to composite materials to take care of the worldwide demand for light weight, superior, ecological benevolent, wear and erosion safe materials. Metal Matrix Composites (MMCs) are appropriate for applications requiring joined quality, warm conductivity, damping properties and low coefficient of warm extension with lower thickness. These properties of MMCs overhaul their usage in the vehicle and tribological applications. In the field of vehicle, MMCs are used for chambers; brake drum and chamber square because of better disintegration obstacle and wear restriction.

Till now, basic work has been done on the formation of MMC's, especially on conveying light and solid composites using aluminum. Various works have been improving the circumstance, sustaining aluminum with strongholds. The present work will focus on assembling mechanical properties of aluminum composite with stone powder strongholds. Moreover, composites are en route towards being even more earth warm. Pitches will unite reused plastics and bio-based polymers. Composites will continue making the world lighter, more grounded, progressively solid, and a better spot than live.

G. G. Sozhamannan, Muttharasan, M. Kaviarasan, K. Prabu, S. B [1] seen that creation of Aluminum composite fortified with broken fired particulates by Stir throwing course will have homogeneous blend and is practical process. The serious issue in this innovation is to acquire adequate wetting of molecule by the fluid metal and to get a homogeneous scattering of the earthenware particles. Arivumangai, A *et al.* [2] had got the test outcomes that, rock powder of peripheral amount as fractional sand substitution has advantageous impact on the mechanical properties, for example, compressive quality, split rigidity, modulus of versatility. Despite the fact that aluminum compounds have such wonderful properties, utilization of aluminum is constrained to a few segments in light of

the fact that, contrasted with ferrous combinations aluminum amalgams have less hardness and wear obstruction, which can be enhanced by blending reasonable support.

Among various aluminum alloys, LM16 (Al-Si5Cu1Mg) is a champion among the most outstanding aluminum blend used for water-cooled chamber heads, valve bodies, water coats, barrel squares, fire hose couplings, air blower chambers, fuel siphon bodies, carrier supercharger covers and equivalent applications, where, spill-proof castings having the top-notch made by warmth treatment are required. LM16 has extraordinary weld ability.

In the context of becoming less thick, negligible exertion, exceedingly strong materials for the vehicle portions, composites were the best choice for securing materials with such sort of properties. In spite of the way that aluminum has superseded most of the ferrous based engine portions like chamber head, chamber, chamber square etc., its utilization was constrained to not a lot of uses due to less wear impediment of aluminum mixes. This can be improved by coordinating aluminum compound with the materials having extraordinary tribological properties.

MATERIALS AND METHODS

Materials

Aluminium alloy (LM 16) and reinforcement graphite and granite powder were employed in this study.

Selection of Matrix

Aluminum is a respectably fragile, solid, lightweight, bendable and malleable metal. Aluminum is important for the metal's ability to contradict disintegration in view of the miracle of passivation. Aluminum has a lower thickness of 2.7 g/cc stood out from 7.8 g/cc of steel. Aluminum composites are lightweight with extraordinary disintegration resistance, flexibility, and quality. The more unmistakable use of aluminum can reduce vehicle weight; improve its execution and reduction fuel costs. Unadulterated aluminum has commonly poor tossing features, subsequently; castings are set up from aluminum composites. The essential alloying segments are silicon, copper, magnesium, zinc, Boron and so on. Aluminum stone amalgams have great throwing and erosion obstruction properties. The expansion of copper to aluminum expands its quality and hardness. The aluminum copper amalgams are warm treatable and have great machinability. These days, aluminum composites are supplanting the ferrous amalgams used to make the car parts.

Despite the fact that aluminum compounds have such wonderful properties, utilization of aluminum is constrained to a few segments in light of the fact that, contrasted with ferrous combinations, aluminum amalgams have less hardness and wear obstruction which can be enhanced by blending reasonable support.

Among various aluminum composites, LM16(Al-Si5Cu1Mg) is a champion among the most notable aluminum blend used for water-cooled chamber heads, valve bodies, water coats, barrel squares, fire hose couplings, air blower chambers, fuel siphon bodies, carrier supercharger covers and practically identical applications, where spill-proof castings having the superb made by warmth treatment are required. LM16 has extraordinary tensile properties

The capacity of a material or structure to extend without breaking under hub draw is named as elasticity. The composite Specimens utilized for the elastic test were readied dependent on the ASTM standard (ASTM: 3039). The malleable properties of composite examples were dictated by INSTRAN-3369 Universal Testing Machine (UTM).

Chemical Composition of LM16 Alloy

According to BS 1490:1988 LM16, the chemical composition and of LM16 alloy is as below

Table 1

Copper	1.0–1.5
Magnesium	0.4–0.6
Silicon	4.5–5.5
Iron	0.6 max
Manganese	0.5 max
Nickel	0.25 max
Zinc	0.1 max
Lead	0.1 max
Tin	0.05 max
Titanium	0.2 max
Aluminum	Remainder

Selection of Reinforcement

Aluminum has incredibly poor wear block diverged from ferrous composites. To grow the hardness and wear properties of aluminum blend, fortress must have tolerably high hardness and wear restriction. Ceramics are the materials which stayed in the best and well before ferrous mixes. If we can make a sound composite with ceramic creation as a stronghold, the composite may have unmatched attributes indistinguishable or better than anything the ferrous mixes. In such way, the help should in like manner have the substance sufficiency while mixing with aluminum. Materials having utilization restriction, self-lubing up properties etc. will be an extra great position in this strategy. Research has recently been started to upgrade the tribological properties of aluminum composite. Different examinations exhibited that the materials like B4C, graphite, stone, garnet, silicon carbide, Boron nitride and titanium carbide, etc. upgraded the hardness and wear properties of aluminum amalgams. This work is prevalently engaged to develop a blend composite reinforced with shake powder particulate.

Construction of Stir Casting Furnace

A conventional stir casting furnace consists of the following basic components i. e. Furnace, Crucible, Temperature Controller, and Stirring Equipment.

Stir Casting

Stir Casting is a fluid state strategy for composite materials creation, in which irregular support is blended with a liquid lattice metal by methods for mechanical mixing. The format of ordinary Stir Casting set up is appeared in underneath figure.

From the outset, the framework metal is softened in the pot and after that, metal treatment (like degassing, fluxing, and so on.) is done without mixing. Afterward, the stirrer is embedded into the cauldron and permitted to pivot the liquid metal. Vortex is shaped in the cauldron because of the turn of the stirrer. The required amount of support is preheated in a different chamber and is bit by bit added to the vortex for uniform blending of fortification into the framework.

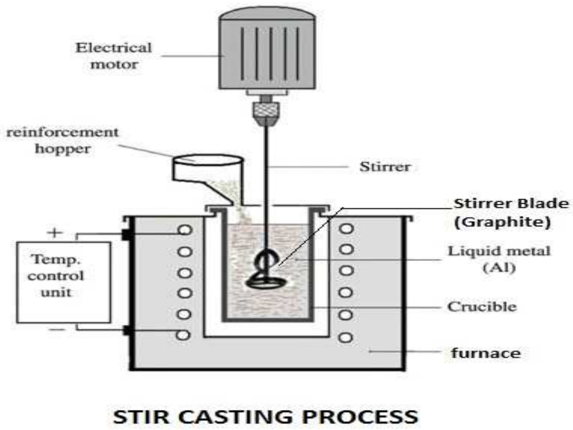

Figure 1.

Table 2

Process	Advantages	Limitations
Stir Casting	Stir casting is one of the most conservative systems for handling Al MMC. The significant favorable circumstances of the blend throwing procedure are its appropriateness to large scale manufacturing, simpler control of grid structure, effortlessness and great network molecule holding.	Challenges with the geometry of mechanical stirrer and position of the stirrer in metal. It is hard to appropriate and scattering of ball processed Nano particles consistently in metal melts.
Compo casting	This procedure will bring about a superior dispersion of support particles and low volume shrinkage of a metal network compound. In the compo, castings have been ascribed to the better weldability between the network and the support particles	Expensive than the stir Casting.
Squeeze Casting	The significant favorable circumstances of the crush throwing procedure are to create quality throwing and offers great surface completion, least shrinkage, and porosity.	High tooling and gear cost.

After the expansion of fortification, stirrer is expelled from the pot and the fluid composite material is then cast by regular throwing techniques and may likewise be prepared by ordinary Metal shaping advances.

Preparation of Furnace

A heater is set up by utilizing a tube-shaped thick sheet metal drum. The internal mass of heater is fixed with a hard-headed earthenware material to avoid heat misfortunes, and is fixed with glass fleece material, which is a readied structure glass to allude (figure 1). The all-out heater was made with kanthaal wire. It is appropriate to create warmth up to 1350 0 C. It is ensured by 15mm thickness of clay material coordinated with 10% of iron.

Figure 2: Furnace.

Preparation of Stirrer

Throwing of metal grid composites (MMC's), the various materials have a distinctive thickness, softening point and breaking point. In any case, other light materials like Aluminum, copper, and magnesium and so forth, have less thickness of liquefying point and breaking point, so molecule blending is hard to light materials. Allude the figure.2. In this way, we utilize the stirrer with 200 rpm high torque reversible engine is taken and associated with a potentiometer for changing rates according to the necessity. The engine shaft is coupled to a tempered steel bar and the opposite end is associated with a graphite three-cutting edge impeller and granulated to the ideal plot for delivering vortex, and it is tried by mixing water in the pot.

Figure 3: Preparation of Stirrer.

Temperature Controller

A temperature controller is an instrument used to control the temperature. To precisely control process temperature without broad administrator inclusion, a temperature control framework depends upon a controller, which acknowledges a temperature sensor, for example, a thermocouple as info. It looks at the real temperature to the ideal control temperature and gives yield to a control component. The controller is one piece of the whole control framework, and the entire framework ought to be dissected in choosing the correct controller.

Figure 4: Temperature Controller.

Procurement of Raw Materials

Figure 5: Aluminium Alloy [LM 16].

Figure 6: Granite Powder.

Figure 7: Permanent Mould.

Figure 8: Specimen Formation.

Sample Preparation

Figure 9: Final Product of Sample.

RESULTS

After warmth treatment, everything considered, every model was freely gone after for the thickness, hardness and unbending nature and the ordinary characteristics were explored by differentiating and the zero model. The results in various tests were discussed underneath. For convenience of presentation and plotting, from here onwards, unadulterated LM-16 composite models were insinuated as sample1; LM-16 with 4% Graphite and 5% Granite tests were implied as sample 2 and LM-16 with 4% Graphite, and 10% Granite tests were suggested as sample 3.

Test Report

Table 3: Total Samples Report

Sl. No.	Test Parameter	Sample-1	Sample-2	Sample-3
1	Hardness[BHN]	106	135	145
2	Tensile strength[$^{N}/_{mm^2}$]	277	284	289
3	Modulus of elasticity[$\times 10^3 \frac{N}{mm^2}$]	71	73.1	76.7
4	Density[$\frac{Kg}{m^3}$]	2703	2683	2688

Physical Properties of Samples

Density

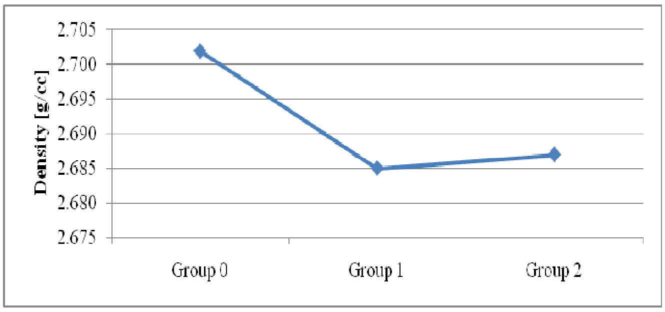

Figure 10: Comparison of Density.

Hardness

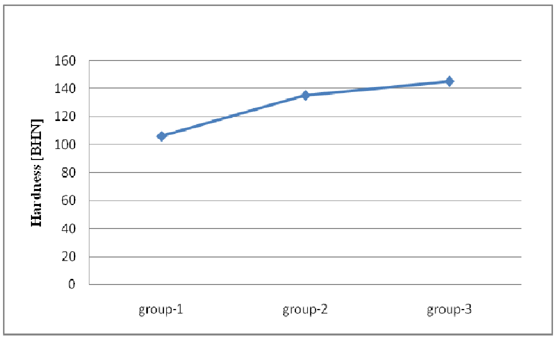

Figure 11: Comparison of Hardness.

Tensile Strength

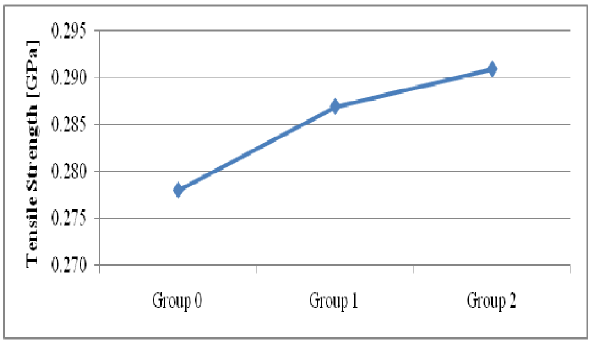

Figure 12: Comparison of Tensile Strength.

Modulus of Elasticity

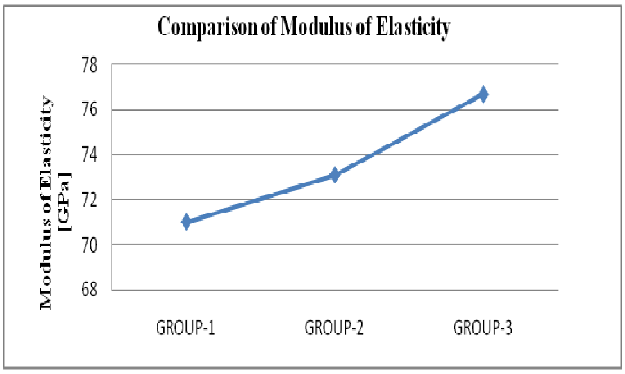

Figure 13: Comparison of Modulus of Elasticity.

CONCLUSIONS

From the trial investigation of present work, the accompanying ends are drawn

- Expansion of stone will build the mechanical properties of the composite.
- The hardness of the composite expanded by 25.9% for 4% Graphite-5% Granite and 37% for 4% Graphite-10% Granite.
- Since stone has an extremely low warm extension and a separator, warm properties of the composite can be read for use at higher temperatures.

REFERENCES

1. *Sozhamannan, G. G. Muttharasan, M. Kaviarasan, K. Prabu, S. B. and Venkatachalapathy, V. S. K. 2014. Influence of Silicon on Performance of Al/SiC Composites. In Applied Mechanics and Materials (Vol. 592, pp. 421–425). Trans Tech Publications. B. C. Pai, R. M., Pllia and G. Satyanaryanak, 1993. Stir Cast Aluminum Alloy Matrix, Key Engineering Materials, 79–80, pp. 117–128.*
2. *Arivumangai, A., & Felixkala, T. (2014). Strength and durability properties of granite powder concrete. Journal of civil engineering research, 4(2A), 1–6. Goretta K C, Wu W Routbort J L Rohatgi P K in P. K. Rohatgi, P. K. Blau, C. S. Yust, Tribology of Composite Materials (eds.), ASM International, OH, (1990) 147.*
3. *Surappa, M. K. (2003). Aluminium matrix composites: Challenges and opportunities. Sadhana, 28(1–2), 319–334.*
4. *Albiter A, Contreras A, Salazar M, Gonzalez-Rodriguez JG. Corrosion behaviour of aluminium metal matrix composites reinforced with TiC processed by pressure less melt infiltration. Journal of Applied Electrochemistry. 2006 Mar. 1; 36 (3):303–8.*
5. *M. A. Belger, P. K. Rohatgi, N. Gupta, Aluminium composite casting incorporating used and virgin foundry sand as particle reinforcements, solidification processing of metal matrix composites-Rohatgi honorary symposium, TMS Annual Meeting (2006), p. 95–104.*
6. *Korkut. M. H, Effect of Particulate Reinforcement on Wear Behavior of Aluminum Matrix Composites, Materials Science and Technology 20.2004, 73–81.*
7. *Hu, H, Squeeze Casting of Magnesium Alloys and their Composites. Journal of Materials Science, 1998, 33, p. 1579–1589.*
8. *Rohtagi, P. K., Aqueous Corrosion of Metal Matrix Composites, in Comprehensive Composite Materials, Volume3: Metal Matrix Composites, T. W. Clyne, Editor. Vol.3, 2000, Pergamon, Oxford UK. p. 481500.*
9. *S. Das, 2004. Development of Aluminum Alloy Composite for Engineering Applications, Indian Institute of Materials, 27 (4), pp. 325–334.*
10. *B. C. Pai, R. M., Pllia and G. Satyanaryanak, 1993. Stir Cast Aluminum Alloy Matrix, Key Engineering Materials, 79-80, pp. 117–128.*
11. *Vibunanthan. M, Vidhusan. C, and vignesh. S., Machinability studies of turning aluminium-SiC-B4C hybrid metal matrix composite using ANOVA analysis" International conference on thermal, material and mechanical engineering, July 15–16, 2012, Singapore.*
12. *Ghasali, E., Pakseresht, A. Rahbari, A. Eslami-Shahed, H. Alizadeh, M. & Ebadzadeh, T. (2016). Mechanical properties and microstructure characterization of spark plasma and conventional sintering of Al–SiC–TiC composites. Journal of Alloys and Compounds, 666, 366–371.*
13. *Karim, M. R., Dilwar, F., & Siddique, R. A. (2018). Predictive Modeling of Surface Roughness in MQL assisted Turning of SiC-Al Alloy Composites using Artificial Neural Network and Adaptive Neuro Fuzzy Inference System.*
14. *Shirvanimoghaddam, K., Hamim, S. U., Akbari, M. K., Fakhrhoseini, S. M., Khayyam, H., Pakseresht, A. H., & Davim, J. P. (2017). Carbon fiber reinforced metal matrix composites: Fabrication processes and properties. Composites Part A: Applied Science and Manufacturing, 92, 70–96.*